Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

25X1

Page Denied

Next 1 Page(s) In Document Denied

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

THE RELIEF OF THE FLOOR AND THE BOTTOM DEPOSITS IN THE NORTH-WEST PACIFIC

By B. P. Petelin

Résumé

Le relief et les dépots du fond océanique dans la partie nord-ouest du Pacifique sont étudiés depuis 1949 par l'Institut d'Océanologie, dépendant de l'Académie des sciences de l'URSS. Le navire "Vitiaz" a été affecté à ces recherches.

Grâce aux explorations effectuées par ce navire, la fosse qui s'étend le long des îles Kouriles et du Kamtchatka est actuellement, entre toutes les fosses océaniques du monde, l'une des mieux étudiées. Sa longueur, dans les limites de l'isobathe de 6.000 mètres, est d'environ 2.000 kms, avec une largeur variant de 20 à 60 kms.

La partie de cette fosse dont la profondeur dépasse 9.000 mètres est située au sud; elle a environ 550 kilomètres de long sur 1 à 5 kms de large. La profondeur maximum de la fosse des Kouriles et du Kamtchatka (point baptisé du nom du "Vitiaz") est de 10.382 m.; elle se trouve par 42°15′2″ de latitude nord et 150°34′2″ de longitude est. La déclivité moyenne des pentes de la fosse est de 5 à 6° dans la partie supérieure, et de 15 à 20° dans la partie inférieure. La régularité des pentes est interrompue par des terrasses et par des escarpements, dont la déclivité atteint par endroit 25°.

Une profondeur de 7.037 mètres a été relevée par le Vitiaz dans la partie occidentale de la fosses des Aléoutiennes, en un point où elle rejoint la fosse des Kouriles et du Ramtchatka. Cette profondeur s'accroît sensiblement en direction des îles Aléoutiennes. La déclivité des pentes nord et sud de cette fosse est de l'ordre de 30 à 40°. La régularité des pentes est interrompue par des terrasses et par des escarpements dont la déclivité atteint 45°. Le fond plat de la fosse a une largeur de 10 à 20 kms. L'existence peu élevées, mais larges, a été décelée du côté océanique de la fosses du Japon, de la fosse des Kouriles et du Kamtchatka et de la fosse des Aléoutiennes. Apparemment, ces ondulations sont liées organiquement à la structure morphologique des fosses.

Un vaste haut-fond où l'on relève des profondeurs inférieures à 3.000 mètres a été découvert dans la zone du Pacifique nord-ouest, où la fosse des Kouriles et du Kamtchatka rejoint la fosse des Aléoutiennes. Nous proposons de donner à ce haut-fond le nom de l'académicien Obruchev.

Il a été reconnu que la crête sous-marine vers le nord-ouest au large des îles Hawai ne prend pas fin à la latitude de 45°, mais qu'elle se poursuit au-delà, en se divisant à la latitude d'environ 49°. Une branche se dirige vers le haut-fond Obruchev, tandis que l'autre se dirige vers la fosse des Aléoutiennes, dans la région des îles Near. Cette crête, dont le sommet atteint 4.000 mètres, divise la partie nord-ouest du Pacifique en deux bassins dont les masses d'eau et le peuplement différent.

Au cours de l'étude faite par sondages acoustiques du fond océanique, plus de 20 montagnes coniques d'une hauteur atteignant parfois 4.500 mètres ont été découvertes; d'intéressantes données sur des détails de la topographie du fond ont été recueillies.

Le carottage de la couche supérieure des dépots marins a permis de dresser des cartes de la répartition des sédiments contemporains et de leurs éléments constitutifs.

Il a été constaté que les dépots océaniques du Pacifique nord-ouest ne renferment pas plus de 20% de silice authigène (amorphe); ces dépots ne peuvent donc pas être classés avec les boues siliceuses à diatomées dont la caractéristique est de renfermer plus de 30% de silice authigène.

Les recherches effectuées au cours des campagnes du Vitiaz ont montré que, dans les parties périphériques de l'Océan Pacifique, l'argile océanique rouge (les brunes ou brown oozes), dont font état les cartes de répartition des sédiments pour le Pacifique nord-ouest, présente à la partie supérieure une mince couche riche en oxydes de fer et de manganèse, analogue à la couche oxydée brune des dépots qui se trouvent dans les régions centrales des mers d'Extrême-Orient. A mesure que l'on va vers le grand large, l'épaisseur de cette couche s'accroît, finissant par atteindre plusieurs mètres. Ctte couche brune est formée par la migration verticale du fer et du manganése, de la zone de réduction à la zone d'oxydation. Son épaisseur est inversement proportionnelle à la vitesse d'accumulation des sédiments. La formation de cette couche dans les sédiments océaniques est facilitée par une plus faible teneur en matières organiques. La couche oxydée brune, dont l'épaisseur varie de quelques millimètres à plusieurs mètres, recouvre le fond de tout le Pacifique nord-est, à l'exception de la crête submergée des Hawai et de plusieurs montagnes, qui sont recouvertes de sables et de boues à globigérines.

D'importantes formations de sédiments résultant du dépôt de particules mises en suspension par des glissements de terrain sous-marins ont été découvertes dans la partie septentrionale de la fosse des Kouriles et du Kamtchatka et dans la partie occidentale de la fosse des Aléoutiennes. L'étude de carottes longues d'environ 34 mètres a montré que la couche sédimentaire supérieure, formée de boues siliceuses biogènes, date de la période post-glaciaire. Selon diverses données, l'âge de cette région est compris entre 8

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

et 20.000 ans; si cette supposition est exacte, la vitesse de formation de la couche de boue siliceuse biogène varie, dans la mer d'Okhotsk, entre 10 à 25 mm et 1 à 2,5 m. par millier d'années, tandis que, dans la fosse des Kouriles et du Kamtchatka, elle varie entre 5 à 10 mm. et 0,5 à 2 m. par millier d'années.

L'étude des carottes a confirmé que les rivages des mers de l'Extrême-Orient avaient subi une double glaciation et que l'activité volcanique de la zone des Kouriles et du Kamtchatka s'était sensiblement accrue au milieu et à la fin du pleistocène.

Not long ago the scientific data on the sea floor relief and the bottom deposits in the Far Eastern seas, as well as in the adjacent part of the North-West Pacific was very scanty. As to the open parts of the mentioned areas, still less was learned about them due to the absence of appropriate technical means employed by the oceanographic expeditions undertaken in those years. Some 25 years ago, Soviet scientists, under the guidance of K. M. Deryugin, P. V. Ushakov and G. E. Ratmanoy, on board of survey vessels "*Gagara*," "*Lebed*," "*Plastun*," "*Rossinante*," "*Krasnoarmeyets*," "*Dalnevostochnik*" and others sponsored by the State Hydrological Institute and the Pacific Institute for Fishery (renamed later into the Pacific Institute for Fishery and Oceanography) collected important data concerning the depths of the Seas of Japan, Okhotsk and Bering. However, the information collected was comparatively insufficient owing to the absence of echosounding devices. The findings of such foreign expeditions as of the *Albatros* (USA) into the Seas of Okhotsk and Bering and into the north-west part of the Pacific, undertaken towards the end of the past and in the beginning of the present centuries, gave very little information to improve our knowledge of the sea-floor relief in the above-mentioned areas; same goes for the *Yamato* (Japan) voyage into the Sea of Japan, in the thirties of this century, the *Tuscarora* (USA) voyage into the area of the Kurile-Kamchatka Trench in the eighties of the recent century, and the *Carnegie* (USA) expedition into the north-west part of the Pacific in the thirties of this century.

The information on the sea floor relief in the Far Eastern seas and in the north-west Pacific, collected prior to the recent World War, was carefully analyzed and studied by Soviet geographers-cartographers when compiling the "Marine Atlas" (1950) and the "Hypsometric Chart of the USSR" (1949). As to foreign studies of the same subject, it is necessary to mention the "Bathymetric Chart No. 6901," published recently in Japan. The Chart sums up the information collected by various expeditions, including the Japanese hydrographic expeditions of 1939–1945.

The study of the bottom sediments in the Far Eastern seas and in the north-west Pacific, undertaken by the above-mentioned expeditions, was also insufficient. The information, concerning the mechanical, and to a certain extent, the mineralogical compositions of the upperest layer of the sediments, published in this country and abroad is inaccurate and superficial.

The vertical investigations of the bottom sediments were either lacking altogether or were made on a very small scale. Such scanty and inaccurate information on the bottom deposits prevented the understanding of the regularity and of the historic process of the sedimentation in Far Eastern seas and in the north-west Pacific in the quaternary epoch.

In the forties of our century, B. A. Skopintsev, of the State Institute for Oceanography, used the information, collected by expedition detailed by the USSR and other countries to compile approximate charts on the distribution of various sediments in the Seas of Okhotsk and Bering. These charts have lost their value following the "Witiaz" vessel expedition, sponsored by the Institute of Oceanology under the Academy of Sciences of the USSR.

The "Witiaz" arrived in the Far Eastern waters in 1949. Since then a systematic, comprehensive study was started of the Sea of Japan, Seas of Okhotsk and Bering, and of the adjacent north-west part of the Pacific. By now, "Witiaz" has completed 20 and is completing its 21st voyage in the Far Eastern waters. One of the principle themes in the plan for comprehensive oceanographic study of the north-west part of the Pacific basin is the investigation of marine geology, conducted under the general guidance of Professor P. L. Bezrukov; this theme includes the investigation of the sea floor relief, of the bottom sediment's nature and of the space and time sedimentation regularities. The sea floor relief to a great extent determines the nature of the dynamic and of the physico-chemical state of the water masses, the distribution and accumulation of bottom sediments, the distribution of various organisms on the bottom surface and so on. This is why the study of the sea floor relief is of such importance for the understanding of the earth crust structure, and for the part played by the relief in the formation of submarine landscapes. The study of bottom sediments reveals the sedimentation regu-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

larities both for the present geological time and for the geological past; it facilitates the understanding of paleogeography and of the geological development of sea basins and of their coasts; it helps to understand the processes of distribution in sediments of certain chemical elements, resulting in the formation of mineral resources of sedimentation origin, it also helps to understand the transformations of the sediment matter at the early stages of the diogenesis. The investigation of the sea floor relief and of the bottom sediments in the contemporary geosyncline region, situated in the Pacific Ocean, is highly interesting. The information obtained from this study enables the scientists to understand the geological processes within the geosynclines of the geological past, occupying vast territories on the surface of the earth and rich with diverse natural resources. The study of the sea floor relief and of the bottom sediments in seas and oceans is of great importance for man's activity, particularly in the sphere of navigation and fishing industry.

In the postwar period (1947-1949) prior to the arrival of "Witiaz" in the Far Eastern waters, the bottom relief of the Japan, Okhotsk Seas and to a certain degree of the north-west Pacific was, to a certain extent, studied by the Kurile-Sakhalin expedition sponsored by the Institute of Zoology of the USSR Academy of Sciences and by the Pacific Institute for Fishery and Oceanography. This expedition conducted echo-sounding operations and gained very valuable information.

Beginning with 1949 the sea floor relief of the Far Eastern seas and of the adjacent part of north-west Pacific was subject of detailed study by a body of scientists of the Institute of Oceanology under the Academy of Sciences of the USSR. This study was conducted by the "Witiaz" vessel equipped with most up-to-date means for oceanographic researches. The soundings, made by the echo-recorders, and the interpretation of the data received was conducted under the guidance of G. B. Udintsev. The tasks and purposes of the sounding operations were determined by the problems of all-round oceanographic research as follows:

1. The research should not be limited to any spectfic depths or areas of investigation. It should embrace the entire area under investigation so that a most detailed picture of the submarine relief was obtained for all depths.

2. The data gained by sounding operations should be presented in a form most suitable for practical use and for scientific conclusions, particularly for the geological interpretations with the aim of finding out the origin of the sea floor relief; its geology and the geological history of the Far Eastern seas and north-west Pacific.

3. Certain regions with intricate submarine relief; both shallow and deep-water regions, presenting particular scientific and practical interest, should be subjected to a more detailed and accurate study as compared with the other areas subject of ordinary all-round investigation.

The Institute of Oceanology of the USSR Academy of Sciences, acting in conformity with these tasks, worked out particular methods for the research work and sounding operations carried out by the "Witiaz" expedition. The principle features of these methods are:

1. Employment of various types of echo-recorders;

2. Application of new methods for echo-recording, providing for highly detailed information on sea floor relief, both for shallow water areas and big depths.

3. Constant, short-interval soundings along the entire route of the vessel.

4. Systematic sounding operations in accordance with the tack-plan prepared for the entire north-west Pacific.

5. Detailed soundings of certain areas presenting particular scientific and practical interest.

The results of the soundings are used for charting detailed profiles for the entire route of "Witiaz", and for the compilation of diverse scale bathymetric charts giving a good picture of the sea floor relief structure.

The bathymetric charts prepared by the Institute of Oceanology under the Academy of Sciences of the USSR are used in various branches of national economy. Thus, for instance, they were utilized for the compilation of a number of maps issued by the State Department for Geodesy and Cartography, as well as in the "World Atlas" (1954), in the "USSR Atlas" (1954), and in the Big Soviet Encyclopedia.

Our plans include the preparation of different specialized geomorphological maps which will facilitate the geological interpretation of the data on submarine topography. The new methods of sounding and the system for analyzing the information obtained is being steadily improved. Alongside of sounding operations a study was conducted of ancient relief buried on the shelf, of the possibilities for the determination of sediments nature and of their cleavage features, with the help of echo-recorders in various depths. The distribution of

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

shoals and of the water-reflecting layer was also subject of investigation.

At present, the larger part of the Sea of Japan, the entire territory of the Okhotsk Sea, the western part of the Sea of Bering, as well as the adjacent north-west part of the Pacific Ocean is covered by a network of sounding tacks. The "Witiaz" has conducted soundings along these tacks, investigating the submarine relief, steading the depths, with sounding intervals averaging from 5 to 50 metres.

Results of the submarine relief study conducted by the Institute of Oceanology on board "Witiaz" include: principle features regarding the composition of the bottom surface in the Seas of Japan, Okhotsk and Bering have been clarified (there had been very little information heretofore on the open parts of these seas); The submarine relief of the Kurile-Kamchatka Arc, heretofore practically unknown, has been studied; the basic pecularities had been determined as regards the sea floor relief of the north-west part of the Pacific Ocean adjacent to the abovementioned seas. A detailed study has been made of a number of regions presenting a particular scientific and practical interest.

Numerous, formerly absolutely unknown, forms of the sea floor relief (submarine elevations, volcanoes etc.) have been found in the Sea of Japan.

It has been determined that the Okhotsk Sea depression is divided into three large basins (fig. 1, 2,): The southern basin, where "Witiaz" registered a maximum depth of 3370 metres, is the deepest. The second basin with a maximum depth of 1744 metres is situated in the north-west part of the depression, by the shores of Northern Sakhalin. We suggest that this basin be named after a well-known explorer of the Far Eastern seas K. M. Deryugin. The third basin, with a maximum depth of 993 m., is located by the mouth of the Gulf of Shelikhov. We suggest that this basin be given the name of the "Pacific Institute for Fishery and Oceanography," which has been conducting investigations of the north-west part of the Sea of Okhotsk for a number of years. The second and third basins are connected with the first basin by two depressions which we suggest to name after Piotr Schmidt and the "Lebed": a survey vessel of the Pacific Institute for Fishery and Oceanography.

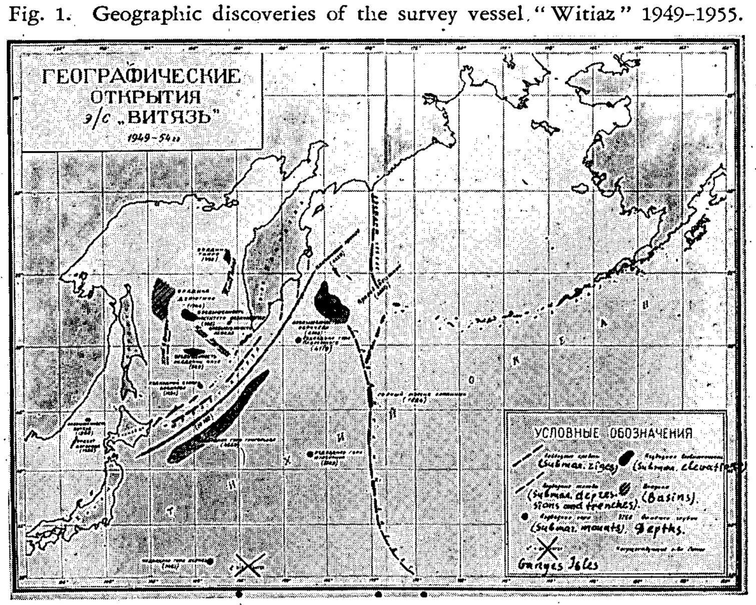
Between these basins lie two submarine elevations which we suggest to name after the Academy of Sciences of the USSR and the Institute of Oceanology. The first elevation has a minimum depth of 894 m. and the second-1000 m. These elevations are separated by a depression which we suggest to be given the name of Stepan Makarov.

It should be noted that this year "Witiaz," covering a special sounding tack, in the southern basin of the Sea of Okhotsk, did not find the submarine mountain shown on the Japanese bathymetric chart No. 6901.

The submarine relief in the area of the Kurile Islands range is characteristic of highly intricate configuration.

According to the data collected by "Witiaz" this range is a complex of two submarine mountain

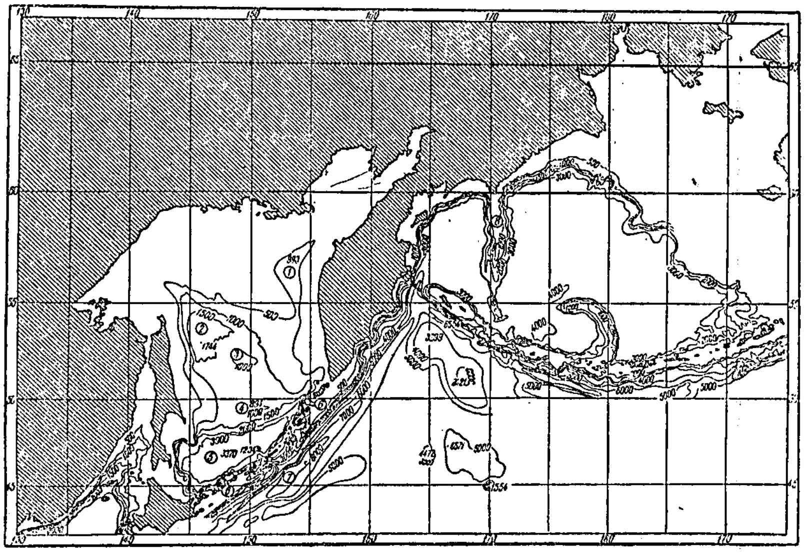
Fig. 1. Geographic discoveries of the survey vessel "Witiaz" 1949–1955.



Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Fig. 2. Bathymetric map of the Far Eastern Seas.



1. Basin of the Pacific Institute of Fisheries and Oceanography.
2. Deryugin Basin.
3. Elevation of the Institute of Oceanology.
4. Elevation of the Academy of Sciences of the USSR.
5. The South Basin of the Okhotsk Sea.
6. The outer ridge of the Kurile Island Arc.
7. The Kurile Trench.
8. Shirshov ridge. Compiled by G. B. Udintsev.

ridges: an outer and an inner ridge, separated by longitudinal depressions and broken up by transversal disruptions (the Bussol and the Krusenstern straits) into three links. More than 35 formerly unknown submarine volcanoes form a chain situated along the north-west slope (open on the Sea of Okhotsk) of this mountain group. One of the largest volcanoes we suggest to name after Academician Sergei Vavilov. The submarine volcanoes are connected with the transversal disruptions of the Kurile mountain complex, and the Kurile Straits pass through these disruptions. The outer i. e. the eastern ridge of the Kurile mountain complex, named after "Witiaz," is covered by the waters of the Pacific Ocean and comes to the surface in the form of Small Kurile Islands only in its southern part. This ridge consists of a northern and a southern link which are connected with the appropriate links of the inner ridge. The outer ridge lacks the middle link, its place being occupied by a broad salient of the south-eastern slope of the inner ridge, the summits of which rise above the sea level in the form of the Big Kurile Islands.

The abrasion flattened surface of the "Witiaz" ridge carries a group of submarine volcanoes.

The structure of the continental Kamchatka slope happened to be rather intricate, too. Three big, meridianal mountain ridges were found there, springing from the capes of Shipunsky, Kronotsky and Kamchatka. There were also found several huge and intricately branching submarine valleys. The initial parts of these valleys stretch in the direction of tectonic depressions and to the corresponding coastal river valleys.

In the Sea of Bering "Witiaz" discovered a submarine ridge stretching meridianally, southwards from the Olutorsky peninsula and dividing the deep-water part of the sea into the western and the eastern basins. The height of this ridge reaches almost 3000 m. We suggest that this ridge be given the name of a well-known Polar explorer, Academician Pyotr Shirshov. Characteristic of the broad shelf of the North-East part of the Sea of Bering is the presence of an ancient buried relief covered by a layer of contemporary sediments. This relief was discovered by means of echo-sounding. It should be noted that the ancient buried reliefs, but on smaller areas, have been also registered in the Sea of Okhotsk, in the South Kamchatka area, and in the Gulf of Aniva.

A long, narrow and deep depression stretching from the Hokkaido Island to the Commadores is situated south-east off the Kurile-Kamchatka Arc. Formerly, this depression was called the Kurile Trench and the bathymetric charts pictured it being shorter, broader and with smaller depths than proved to be true. As has been found out, this trench runs not only along the Kurile Islands, but along the

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Fig. 3. Schematic bathymetric map of the Kurile-Kamchatka Trench, compiled from the materials of the Institute of Oceanology of the Academy of Sciences of the USSR collected by the survey vessel "Witiaz" in 1949–1953. Compiled by G. B. Udintsev.

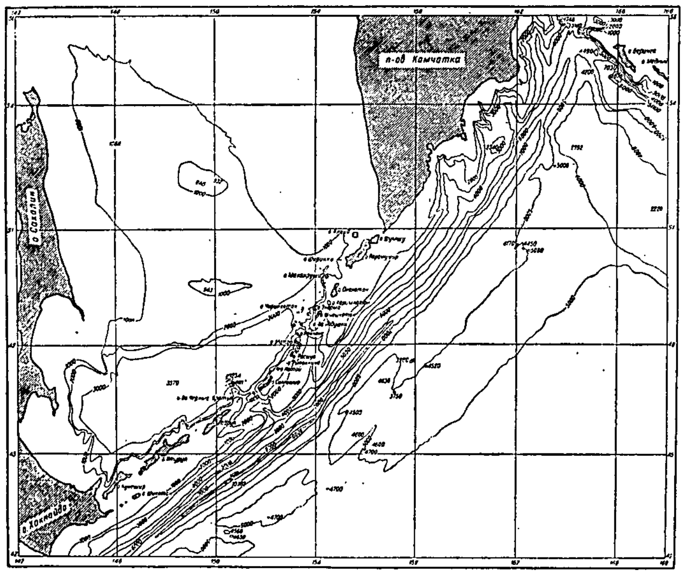
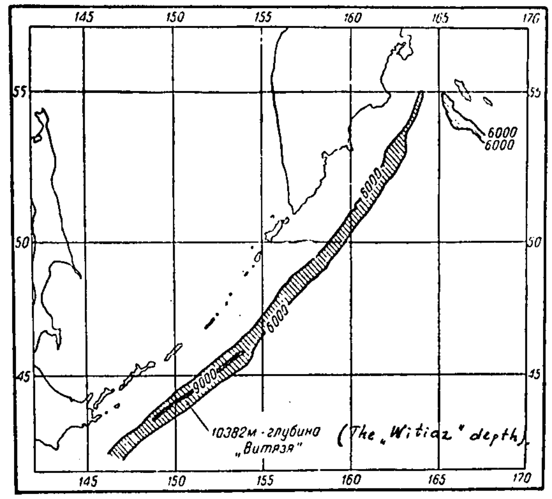
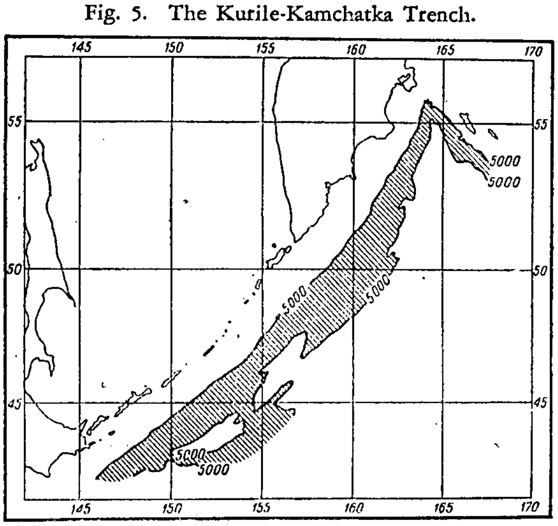


Fig. 4. The Kurile-Kamchatka Trench.



Lines–depths exceeding 6000 m.
Black–depths exceeding 9000 m.
Compiled by G. B. Udintsev.

Fig. 5. The Kurile-Kamchatka Trench.



Lines–depths exceeding 5000 m.
Compiled by G. B. Udintsev.

Fig. 6. Cross-section of the Kurile-Kamchatka Trench. The vertical scale being 37 times larger than the horizontal. Compiled by G. B. Udintsev.

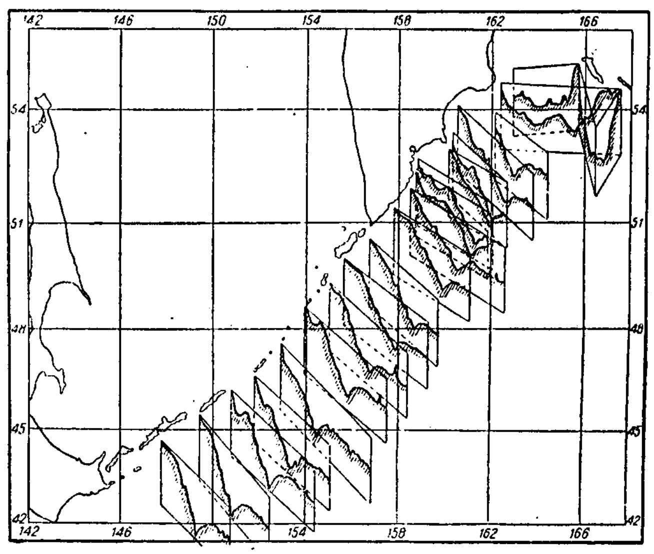
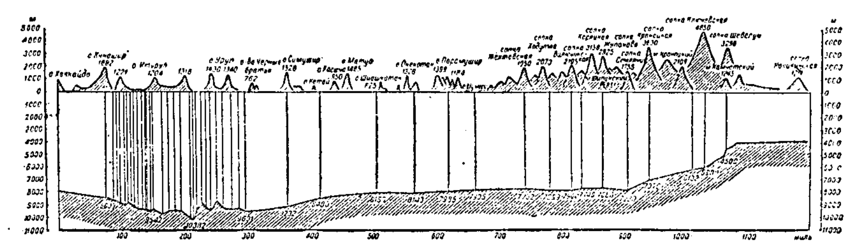


Fig. 7. Longitudinal profile of the Kurile-Kamtchatka Trench. Vertical lines correspond to maximum depths of the depression, the measurements made during transversal crossing of the depression. The vertical scale being 30 times larger than the horizontal. Compiled by G. B. Udintsev.



Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Kamchatka, too. Therefore, it was deemed expedient to substitute its former name with a new one and to call it the "Kurile-Kamchatka Trench." (fig. 3, 4, 5, 6, 7)

Thanks to the comprehensive oceanographic investigations conducted by the "Witiaz," the Kurile-Kamchatka Trench may be considered the best studied trench of the World Ocean. It takes its beginning close to the Tsugaru Strait latitude, stretches north-eastwardly and enters a strait between the Kamchatka and the Commadore Islands. Heretofore, this strait had no name and therefore we suggest to call it the Kamchatka strait. The length of the trench within the 6000 m., isobath reaches almost 2000 km., its width ranging from 20 to 60km.; (its southern part is the broadest). Here are the depths exceeding 9000 metres, stretching for about 550km long and 1–5 km wide. The maximum depth of the Kurile-Kamchatka Trench (the "Witiaz" depth) is 10382 m.,–50 metres, at 44°17,6′ N. Lat., 150°30,1′ E. Long.

The transversal profiles of the trench are strictly V-shaped for the entire length.

The mean slope steepness in the upper part of the trench is 5–6°, and in the lower 15–20°. The slopes are broken up into terraces and escarpes, their steepness reaching and, at certain spots, even exceeding 45°. The deepest part of the trench has a flat bottom, with the width close to 1 km in depths exceeding 9000 metres, ranging from 8 to 10 km in depths close to 8000 m. in the middle part, but in the majority of cases it does not exceed 5 km.

It seems probable that the Kurile-Kamchatka Trench originated in the south and is developing northwardly, as can be judged from the growth of the volcanic activity in the same direction, and also from the tilt of the flattened surface of the "Witiaz" submarine ridge towards the deepest southern part of the trench.

The Aleutian Trench was itvestigated by the "Witiaz" only in its western part, beginning from the place where it joins the Kurile-Kamchatka Trench and to the meridian 60 miles West off the Attu Island. In the West, where both trenches come together, and where a submarine elevation, with depths below 3000 metres, lies on the ocean floor, (we suggest that this elevation be given the name of Academician Obruchev) the width of the flat bottom of the trench, within the limits of the 7000 m. isobath, reaches 20 km. Here the maximum trench depth, found by "Witiaz", is 7037 m. The slopes of the trench are very steep: 30–40° on the side of the Obruchev Elevation, and 30–35° on the side open on the Commadores. The flat bottom of the studied part of the Aleutian Trench, in the East, is 9–10 km wide, within the limits of the 7000 m. isobath: Here, the maximum depth of the trench exceeds 7250 m. Between the western and the eastern parts of the investigated stretch of the trench there seem to lie a practically unknown submarine sill. The slopes of the Aleutian Trench, as those of the Kurile-Kamchatka Trench are disrupted by escarpes and terraces, their steepness reaching 45°. In the area of the Obruchev Elevation, one such escarpe, high 1600 m. and 40° steep, was traced for 70 km.

Investigations in the northern part of the Japan Trench revealed its morphological similarity with the Kurile-Kamchatka Trench. It had been determined that depths exceeding 8000 m., formerly shown for this area, are incorrect, actually they do not exceed 7600 m.

The sea floor of the North-West Pacific, studied by the "Witiaz", has a number of singular features. For example a broad swell stretching by the very edge of the ocean floor along the Kurile-Kamchatka Trench and finally merging with the Obruchev Elevation. The swell rises some 200–300 m above the ocean floor, however, its height increases as it nears the Kamchatka strait. A number of conical mountains and hills with steep slopes, contrasting against the relatively flattened landscape, have been found on the crest of this swell which we suggest to name the "Zenkevich Submarine Elevation." We believe that these conical mountains are of volcanic origin.

Another swell was found on the southern side of the Aleutian Trench, and the third on the eastern side of the Japan Trench. Most likely these swells are connected organically with the morphological complex of the trenches. A submarine ridge runs from the Hawaii to the north-west. It was supposed heretofore, that this ridge, disrupted into separate mountains, ends approximately at the 45° Lat., however, the information obtained by "Witiaz" in 1954 proved that this ridge stretches hundreds of miles across the northern part of the ocean and falls into the Obruchev Elevation. Hence, the depths exceeding 6000 m. shown previously on the maps for this region, do not exist; in fact, there stands a tremendous mountain ridge almost 4000 m. high, linking the Hawaiian ridge with the Obruchev Elevation. Certain summits of this ridge rise to depths offstanding from the surface 1200–1500 m. The summits of this submarine ridge are flattened, most likely by abrasion.

In 1955 the investigations of the ocean floor,

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

south of the Aleutian Trench showed that this ridge branches at 49° Lat., the greater branch (2120 m high and 30 miles wide at the foundation) runs north-westwardly towards the Obruchev Elevation, while the other (2760 m. high and with a foundation width of 35 miles) stretches northwardly to the Aleutian Trench in the region of the Near Aleutian Islands (fig. 1). Transversal soundings of these branches proved that their slopes are disrupted by escarpes, some of them several hundred metres high with steepness reaching 40–45°. Somewhat west, off the north-westward branch we crossed a submarine ridge almost twice less in height and further on a number of still lower ridges separated by longitudinal depressions were crossed. Hence, it may be supposed that the north-westward branch gives, in its turn, other branches. Thus, it has been determined that the northern part of the Pacific Ocean is divided by a submarine ridge into northwestern and northeastern basins, the ridge stretching from the Hawaiian Islands to the western part of the Aleutian Trench.

Both sides of the ridge are washed by two separate masses of water, differing as regards their physical-chemical characteristics, and populated by different associations of deep-water fishes and bottom animals. Another important feature of the sea floor relief of the north-western basin is a vast plateau rising above the ocean floor 1500 metres and stretching north-eastwardly from the 31 to the 44 parallel.

The sea floor structure in the investigated part of the Pacific Ocean is more intricate than the floor structure in the Far Eastern seas, however, it is less complicated than the relief of the continental slope which is particularly intricate in the Sea of Bering. Various relief elements can be found on the surface of the ocean floor: closed basins with absolutely flat surfaces, hills, branching depressions, steep escarpes etc. The variation in the ocean floor depths, in certain cases, reach 200–300 metres. The data on the small forms of the Pacific Ocean's bottom relief has been obtained by means of new methods of echosounding and was unknown heretofore.

The zone of highly disrupted sea floor surface in north-west Pacific stretches parallel to the Kurile-Kamchatka Arc, some 100 miles away from the axis of the Kurile-Kamchatka Trench. This is a zone of tectonic disruptions of the ocean floor, as can be judged from several profiles, prepared on the basis of the sounding results received by a transversal tacking of zone in question. The ocean bottom relief is characteristic of separate submarine mountains with heights up to 3000 m. and steepness reaching 25°. At present, "Witiaz" has discovered more than 20 such mountains in the investigated part of the ocean. One of the largest mountains, 4500 metres high, east off the Japan Trench we suggest to name after Admiral Isakov.

In 1954 "Witiaz" made a study of the area where according to the maps was a group of the "Ganges" Islands, consisting of four islands and a number of reefs. No islands were found at that place. Moreover, the place mentioned, lacked even more or less noticeable submarine mountains the summits of which could have risen above the surface in the form of islands and rocks or rise to the surface in the form of banks.

"Witiaz" has collected abundant material for the study of bottom sediments in the Far Eastern seas and the adjacent north-west Pacific. These materials were collected with the employment of new devices, designed at the Institute of Oceanology. Mention should be made here of most modern core samplers, of new designs of bottom samplers, of a device for mass collection of water and atmospheric hard suspension samples, of an apparatus for the determination of bottom sediment thickness, etc. Echo-recorders have been used extensively in the investigation of the nature of the sediments in various depths and in the structure study of the bottom sediments layer for several scores of metres in depth. The data and the samples collected, have been subjected to an all-round investigation: the study of the mechanical composition of all types of sediments, including the deep sea big fragmentary material, and their mineralogy; chemical and spectroscopic methods are used to study the elements distribution in the sediments, a micropaleontological analysis of the sediments was also carried out (the study of pollen and spores of ground plants, the remnants of diatom algae and foramineferas), as well as the study of the organic matter and plant pigments found in the sediments. Atmosphere and water hard suspended matter represent a rudiment in the initial stage of formation were also studied in detail. The study of the bottom deposits is conducted under the guidance of Professor P. L. Bezrukov at the laboratory of marine geology under the Institute of Oceanology.

The area of the north-west part of the Pacific basin, investigated by "Witiaz" has been covered by a comparatively proportional network of geological stations, their total number exceeding 2600. The investigation of samples taken from the upperest layer of bottom sediments enabled us to prepare distribution charts for various types of contemporary

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

sediments and their components. The study of sediments revealed a number of new types of facial varieties, unknown for the studied area. These include certain volcanic sediments, pebble-gravel deposits originating from the transporting action of the ice and algae, various biogenic sediments, the bulk of which consists of animal remnants with silicon (diatom oozes, silicon-sponge sediments), and limy sceletal parts (foramineferal sands, sediments composed of sceletal parts of hydrocoralls briozoa, ciripedia and various mollusca).

The combination of diverse factors of terrigenic, volcanogenic and biogenic sedimentation under complex conditions of climate, bottom morphology and water mass dynamics produces a great variety in the distribution of bottom sediment types and in their composition. Against the general background of the distribution of sediment types in the Far Eastern seas and in the adjacent part of the Pacific Ocean, the areas of tectonic and volcanic arcs are characteristic of singular complexity. Extremely varied distribution of sediment types, similar to that of the geosynclines of the past, as well as of zones of great sediment accumulation and of zones with practically complete absence of contemporary sedimentation has been found in these areas.

In the study of sediment composition much attention was given to the relation between their terrigenic components and the composition of the coastal rocks. Basing upon the results of the petrographic analysis, (A. P. Lisitsin) of big fragmentary material, widely present in the sediments of the Far Eastern seas, a number of provinces with specific petrographic composition was detected on the sea floor, moreover, the paths of transportation of the material from coastal supplying provinces were traced also. This investigation proved the significance of drifting ice and algae for the transportation of big fragmentary material; it also established a broad distribution in the peripherial part of the ocean of rocks transported from the coasts of the Sea of Bering, the Kamchatka and the Kurile Islands.

The information obtained from the mineralogical analysis of the sediments helped to determine a number of mineralogical provinces in these seas. On the basis of study of numerous distribution charts of various minerals (for the Okhotsk Sea, more than 40 charts were prepared by B. P. Petelin, and for the western part of the Sea of Bering, more than 30 were prepared by A. P. Lisitsin) the paths and means of their transportation into the sediments from the supplying provinces were defined. It should be also noted that launching of such large-scale and detailed mineralogical research is unprecedented. Besides the allotigenic minerals, the aggregate number of which in the sediments of the Far Eastern seas is almost 100, a number of new authigenic minerals was found and partially studied. These minerals originating at the early stages of the diagenesis include glauconite and calcite, described for the Sea of Okhotsk by B. P. Petelin, and iron sulphides, studied by E. A. Ostroumov in the sediments of the entire investigated area, and other minerals.

During the study of sediment composition, much attention was given to chemical investigation conducted under the guidance of Doctor E. A. Ostroumov. This investigation was characteristic of multitude in the number of components that were subject of defining (organic carbon, carbonates, authigenic silica, phosphorus, vanadium, titanium, diverse compounds and total content of iron, manganese, sulphur, etc.) Detailed chemical research of the sediments brought to light certain new features in the distribution of such elements as iron, manganese, phosphorus, vanadium and titanium. Thus, for instance, as we draw closer to the Kurile-Kamchatka volcanic belt, with the transition from fine sediments to coarse ones, the presence of these elements does not diminish, as was usually witnessed, but, to the contrary, increases radically. This is so owing to the pecularities of the petrographic composition of the rocks in the supplying provinces and the conditions of their weathering.

The general pattern of the sediment types distribution in the Far Eastern seas may be described in the following way. Sea floor sectors lacking sediments, bolder-pebble and gravel-pebble sediments and the sands are usually characteristic of the near shore shallow waters. Their distribution depends greatly upon the dynamics of the sea floor waters and upon the material transported from the coasts. We also find here various biogenic carbonate and silicon sediments. On the shelfs and in the sectors with slow bottom waters we can meet also finer sediments of silt or clay-silt types, distinguished, in a number of cases, by a sharply expressed process of iron sulphydes formation (hydrotroilite, marcasite) and of free hydrogen sulphyde, the latter is usually abundant in the sediments of fjord type bays. The dimensions of the sedimentation material decreases with progress to the lower parts of the shelf where the silts are predominating.

It should be noted that the fragmentary material present in the Far Eastern sediments is distinguished by great mineralogical diversity. The reason for this is the great variety in the petrographic com-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

position of coast rocks and also by the fact that the fragmentary material coming with the drainage waters in the form of wave and ice abrasion products, in the form of volcanic products, etc, does not suffer any noticeable changes in its composition owing to climatic or other conditions.

Alongside of silt sediments, the shelf, particularly its upper part, is often characteristic of rocky regions surrounded by zones of pebble and gravel sediments and sands. Their distribution is dependent upon both, the dynamics of the sea floor waters and on the continental slope relief. Towards the lower part of the continental slope we usually witness a decrease in the coarseness of sediments and the predomination of silty, silty-clay and clay sediments. The fine sediments of the continental slope, in some places, are highly characteristic of iron sulphyde formation. The bottom of the open parts of the Far Eastern seas is usually covered by clay-diatom and diatom oozes with interlayers of volcanic ash. The greenish-gray diatom and clay-diatom oozes in the central parts of the seas have an upper brown oxidyzed layer conditioned by the presence in the oozes of iron and manganese in the higher degrees of oxidation. The thickness of this oxidyzed layer of clay-diatom and diatom oozes ranges from several milimetres to 8-10 centimetres. The content of authigenic (amorphous) silica, present mainly in the shells of the diatom algae and determined in a double 5% soda extract, in the sediments of this type reached 56% in several samples. According to data presented by P. L. Bezrukov the greatest content of authigenic silica is found in the deep-water sediments of the Sea of Okhotsk. These sediments, in the very centre of the sea, are in fact typical diatom oozes with a specific weight of 0.4. According to A. V. Solovyov the maximum content of the authigenic silica in the deep-water sediments of the Sea of Japan reaches 20-25%, while in the Sea of Bering (according to A. P. Lisitsin)-34%.

Against the general background of fine sediments with pelitic fractions content reaching 85%, there are cases when silts and even sands are found in the open parts of the seas. The existence of this phenomenon is explained by the presence of substantial submarine elevations of such type as the Shirshov ridge in the Sea of Bering, and of such elevations as the " Academy of Sciences " and " Institute of Oceanology", in the Sea of Okhotsk. Another reason for this may serve the relatively high velocity of bottom waters caused by other factors than the decrease in the cross section of the water mass above the submarine elevations.

Within the area of the Kurile mountain complex with an intricate sea floor relief and strong tidal currents, the region of the sea floor deprived of sediments or covered by very coarse sediments such as bolders, pebbles and gravel are found even in depths of 1000-3000 metres. These sediments have been detected not only upon positive forms of the submarine relief (submarine mountains and volcanoes), but upon negative forms (trench slopes deep straits) too. Here, sands are found in depths up to 3200 metres, while silts have been registered in depths reaching 5000-6000 metres. Common for these regions are carbonate sediments composed of sceletal parts of ciripedia, of various mollusca, hydrocoralls, briozoa, foramineferas and others. In certain places 80% of the sediment content consist of the skeletal elements of the *silica sponges*, which may be considered analagous to the spongolites (B. P. Petelin). The main role in the formation of such sediments is played by the remnants of sponges, (Monoctinnelida and Tetractinnelida).

Mineralogical composition of sediments in this area as compared with the same for the sediments of the continental shelf zones and for the sediments in the open parts of the Far Eastern seas is rather poor. This is explained by the fact that the principle role in the sediment formation is played here by the products of volcanic activity, their composition corresponding most of all to pyroscenic andesites. This is why the basic minerals of these sediments include only volcanic glasses, fragments of volcanic rocks, plagioclases, pyrocsenes and magnetite. In small quantities we find admixtures of quartz, potassium feldspar, common and basaltic hornblendes. Such elements as titanite, rutile, zircon, analcime and others are very rare. The presence of authigenic glauconite, the formation of which in the sediment takes place at the early stages of its diagenesis (B. P. Petelin), was found in the southern part of the Kurile Archipelago area. This glauconite, as compared with the glauconites found in other places, is distinguished by a low content of K_2O (1.85%). Judging by the debyegramm, its structure is very close to that of nontronite.

The sea floor sectors lacking sediments are being met in great depths and trenches. Thus, during the deep sea trawling on the western slope of the Japan Trench, the trawl brought fragments of argilite rock type from depth of 6600 metres. Similar rocks were delivered by bottom samplers from the "Witiaz" submarine ridge and by trawls from the western slope of the Kurile-Kamchatka Trench. Deep sea trawling on the southern slope of the Aleutian

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

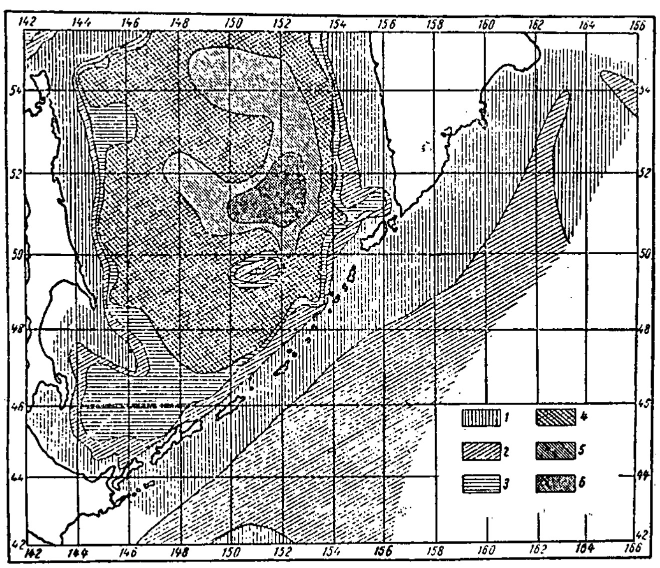
Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Trench gave fragments of magmatic rocks with a fresh break on one of the sides, as well as fragments of green and pink tuffogenic argillites from depths close to 7000 metres. Exceedingly steep tilts of the escarpes, characteristic of the trench slopes, prevent the accumulation of sediments and the bottom rocks stand bare. Sediments of diverse mechanical composition may be found here depending upon the tilt angles and the relief of the trench slopes. The floor of trenches is covered by weak diatom clay oozes with a very thin (several milimetres) oxidyzed brown layer with volcanic ash interlayers. The investigation in the western part of the Aleutian and the northern part of the Kurile-Kamchatka Trench revealed a widely spread development of peculiar sediments. The origination of these sediments is traced to the submarine slips from the slopes of trenches (B.P. Petelin and E.A. Ostroumov). These sediments are present in the form of semi-liquid clay mud with an admixture of silt and sand, particularly in the lower part of the horizon, re-deposited from slip suspensions with mechanical differentiation of material. During the same investigations, a new authigentic mineral, unknown in literature, was found in the dense clay-diatom ooze of the Kurile-Kamchatka Trench, 45-55 centimetres below the surface of the sediment. The mineral was present in the sediment in the form of irregular, transparent crystals of yellowish colour with the sediment matter penetrating a certain depth of its surface, the dimension of the crystals reached one centimetre. There was no time to subject it to a microscopic analysis and it was left for one day in the laboratory. By next day the crystals turned into a white powder. When several small partially decomposed and nontransparent fragments, extracted from the powder, were subjected by B. P. Petelin to a microscopic analysis, they were classed with carbonates and the rhomboid singonium of the crystals was determined. Accurate determination of optical constants was already impossible because by that time the mineral had lost its principle optical properties. E. A. Ostroumov, by means of qualitative chemical analysis, confirmed that this mineral belongs to the carbonate group. The mineral proved to be a calcium carbonate with an admixture of manganese and traces of sodium.

Inasmuch as crushed shell material of molluscs was found in the sediment, it may be supposed, that this material served the origin for the formation of the abovementioned mineral. Hence, the mineral is a calcium hydrocarbonate, the existence of which appears to be possible only under high pressure conditions which at that spot (8000 m.) exceeded 800 atmospheres. Under the conditions of normal atmospheric pressure, the mineral lost its crystalization water and quickly decomposed.

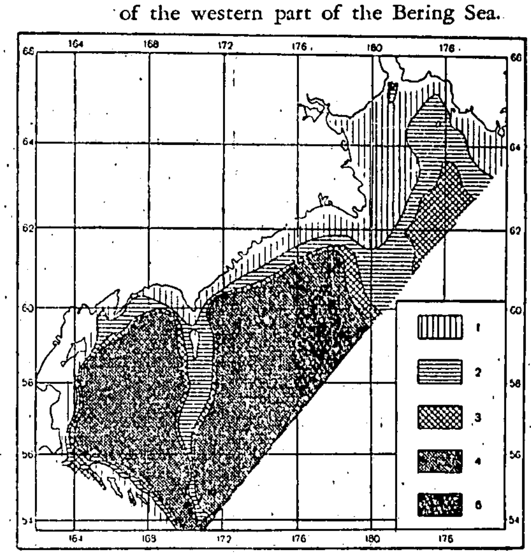
The ocean floor is covered by clay sediments

Fig. 8. The distribution of amorphous silica sediments in the surface layer.



1. Below 10%;
2. 10-20%;
3. 20-30%;
4. 30-40%;
5. 40-50%;
6. Above 50%. Compiled by P. L. Bezrukov.

Fig. 9. Schematic chart of the amorphous silica distribution in the surface sediment layer of the western part of the Bering Sea.



1. Below 5%;
2. 5-10%;
3. 10-20%; Compiled by A. P. Lisitsin.
4. 20-30%;
5. 30-40%.

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

containing up to 20% of authigenic (amorphous) silica acid, which is mainly present in the skeletal remnants of the diatom algae. Formerly, a broad band of diatom oozes was shown on the charts for the north-west part of the Pacific.. However, it turned out that the north-west Pacific sediments, judging by the authigenic silica content, cannot be classed with the silica-diatom oozes. The bottom sediments of the open parts of the Sea of Okhotsk (30–35%) and those of the Sea of Bering (30–34%), where formerly only terrigenic sediments were registered, may be classed with the abovementioned oozes. (fig. 8, 9).

The "Witiaz" expeditions succeeded in proving that the so-called red oceanic clay (the brown oozes) is a thin surface layer of bottom sediments enriched by iron and manganese oxydes. It is similar to the brown oxydized layer of sediments in the central regions of the Far Eastern seas. The thickness of this layer increases with progress towards the open parts of the ocean, beginning with several scores of centimetres and reaching several metres. However, within the limits of the entire investigated area of the ocean greenish-gray weak silicon-clay or clay oozes were found under the brown layer.

The formation of the brown oxydized sediment layer, which possibly is in itself the red oceanic clay, (according to the data presented by academician N. M. Strakhov) occurs owing to the vertical migration of iron and managanese from the reduction zones of sediments into the oxydizing zone and the conversion into the low solvent oxyde forms. The thickness of the brown oxydized layer is greater in the sediments with low accumulation velocity inasmuch as the mineral formation process in the oxydized zone will be vividly expressed only in that case if it continues for a long time. In the case of a rapid rate sedimentation, the oxydizing conditions in the lower horizons of the sediment may quickly change to those of reduction and a transition of the iron and manganese oxydes into the protoxydes will be witnessed. This is why extensive development of the brown oxydized layer takes place in the pelagic regions where the sedimentation rate is very slow and the organic matter content in the sediments is much lower than in the coastal areas.

The clay sediments of the studied part of the ocean have a brown oxydized layer of variable thickness and are usually characteristic of volcanic ash interlayers and of dispersed big fragmentary material, the surface side of which, within the limits of the brown layer, is always covered by iron and manganese oxydes. Alongside of these oxydes, iron-manganese nodules with nuclii in the form of pebbles of various volcanic and sedimentary rocks are often met too. Globigerina sands and oozes, some times with an admixture of small iron-manganese nodules were found on the surface of the Hawaiian submarine ridge and on separate big submarine mountains, in depths of 1500–3000 m. This, interesting in itself fact, of globigerina oozes being present in the northern parts of the Pacific proves that their distribution in the ocean is associated not only with the distribution of limy foramineferas, but with the conditions of the sea floor relief. The investigations of the sediments of the north-west Pacific of the Sea of Okhotsk revealed that there are definite depth limits, determined by the physical-chemical state of waters, up to which the shells of the globigerina may take part in the sediment formation. However, below these depths they dissolve in the water before reaching the bottom. In the central part of the Sea of Okhotsk the globigerina shells are present in the sediments up to the depth of 1500 metres. In the north-west part of the Pacific, i. e. in the warmer, and consequently, less aggressive waters, the globigerina's shells take part in the sedimentation in depths reaching 3000 metres.

The methods of lithological and diatomic (A. P. Zhuze), pollen-spore (E. V. Koreneva) and the foraminiferal (H. M. Saidova) were employed in the analysis of sediment cores almost 34 m. long. It should be noted here that it is the first time when the pollen-spore and the diatom methods of the analysis of the stratigraphy of recent bottom deposits have been successfully employed on such large scale.

The upper parts of the deep-water sediment cores in the Far Eastern seas and in the adjacent part of north-west Pacific are composed of diatom and clay-diatom oozes of gray-greenish colour with a brown oxydized layer, in areas suitable for its development. The thickness of these sediments, on the studied area, varies from 0.2 to 20 metres. Further down, their place is taken by bluish-gray clays with gradually increasing density. The lower part of these clays has not been penetrated by the core samplers used in the expeditions. Interlayers of volcanic ash varying in thickness have been found in the clay-diatom oozes and in the underlying clays. Mineralogically these interlayers correspond mainly to various types of andesites or are composed of colourless volcanic glass fragments.

As has been determined, the upper layer of the diatom and clay-diatom oozes dates back to the epoch commencing with the end of the last glacia-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

tion. If, according to various data, this period continues 10–20 thousands years, the velocity of sedimentation in the Sea of Okhotsk ranges from 10–25 mm to 1–2.5 m. per 1000 years, while in the Kurile-Kamchatka Trench-from 5–10 mm to 1–2 m. per 1000 years. Hence, the rate of sedimentation in trenches is higher than has been previously supposed.

Accoring to the data obtained from micropaleontological research two horizons are distinguished in the layer of the bluish-gray clays, each corresponding to an appropriate glacing period. Therefore, the double glaciations of the coasts of Asia in the quaternary period, determined by the geological land study has been confirmed by geological research of the marine sediments. Our findings also confirm the radical activization of the volcanoes in the Kurile-Kamchatka zone during the middle and the closing period of the pleistocene. The study of the bottom sediment cores showed that marine environment existed in southern parts of the Okhotsk and Bering Seas throughaut the quaternary epoch. Hence, the supposition that fresh water basins had recently existed there has found no confirmation.

In the course of the "Witiaz" expeditions a study has been made of the thickness of the incoherent oceanic sediments by means of seismoacoustic sounding (i. e. the method of reflected and refracted waves.). The material, collected on extensive area, so far has not been studied sufficiently and therefore no results of this investigation are mentioned here.

Submarine photography is very helpful in the investigation of the upper-most layer of bottom sediments. The photographs of the bottom surface, picture the activity of the bottom animals, the microrelief elements and the dimensional distribution of sediments.

Engineer N. L. Zenkevich used cameras for submarine photography, of his own design, and obtained series of good pictures of the sea floor in depths reaching 2860 m.

Concluding the description of the results obtained by the Institute of Oceanology in the course of the "Witiaz" geological researches a mention has to be made that they cannot be exhausted in such a brief paper.

Only most general information is given here. To form a more or less complete opinion as regards one or the other aspects of the geological researches conducted by the Institute of Oceanology, reference should be made to the works by P. O. Bezrukov, E. A. Ostroumov, G. B. Udintsev, A. P. Lisitsin, A. P. Zhuze, E. V. Goreneva, N. L. Zenkevich, H. M. Saidova, B. P. Petelin, and others.

Survey voyages of the "Witiaz" and detailed study of the information collected continues. It will make available new facts helpful in a better understanding of the geological past of the Pacific Ocean and in the pecularities of the sedimentation on the territory of the Pacific Ocean for the present geological period and for the past geological epochs.

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

25X1

Page Denied

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

БЮЛЛЕТЕНЬ М. О-ВА ИСП. ПРИРОДЫ, ОТД. ГЕОЛОГИИ. Т. XXXIII (2), 1958

О некоторых особенностях распределения железа в осадках Охотского моря

В. П. Петелин и *Э. А. Остроумов*

Содержание. В статье рассматривается распределение железа в современных осадках Охотского моря. Основная его масса поступает с обломочным материалом как за счет выноса с суши, так и с продуктами современной вулканической деятельности. Больше всего железа содержится в прибрежных районах, тогда как центральные части моря значительно обеднены им. Авторы приходят к выводу, что Охотское море следует, с точки зрения распределения железа, выделять в особый тип бассейнов — с максимальными кларковыми концентрациями железа в прибрежных зонах.

Исследования, проведенные в 1949—1953 гг. на экспедиционном судне «Витязь» [20], показали, что распределение железа в донных отложениях Охотского моря имеет особый характер, резко отличающийся от установленного для других морей [29]. Настоящее сообщение имеет целью изложение результатов исследования по определению источников и форм нахождения железа в осадках, предпринятого нами для того, чтобы выяснить причины, обусловливающие характер его распределения. При описании материала мы придерживаемся тех названий участков рельефа дна Охотского моря, которые приведены на карте в работе П. Л. Безрукова и Г. Б. Удинцева [2].

Установлено, что наибольшие концентрации железа (в среднем 5%) наблюдаются в песчаных осадках районов, прилегающих к Курильским островам и Камчатке (рис. 1, 2). Максимальное содержание его в песках, достигающее 11,11%, отмечено в Четвертом Курильском проливе (рис. 1). В алевритовых илах прибрежной полосы Курильских островов и Камчатки содержание железа в среднем около 3%. В осадках Курило-Камчатской прибрежной полосы железо связано с обломочным материалом, поступающим в море в виде продуктов дезинтеграции горных пород побережий и продуктов современной вулканической деятельности.

Питающие провинции Курильских островов характеризуются широким развитием изверженных пород и их туфов. Осадочные породы обнажены на сравнительно небольших площадях только на севере и юге архипелага и существенного влияния на характер обломочного материала, поступающего в море с Курильских островов, не оказывают. Среди изверженных пород Курильских островов преобладающее значение имеют пироксеновые андезиты, базальты и их туфы, тогда как кислые породы (риолиты, дациты) играют подчиненную роль [8, 12, 24]. Обломочный материал, получающийся в результате разрушения горных пород Курильских островов, в основном отвечает по составу пироксено-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

вым андезитам и базальтам и характеризуется значительными количествами таких железосодержащих минералов, как магнетит, ромбические (гиперстен) и моноклинные (авгит) пироксены.

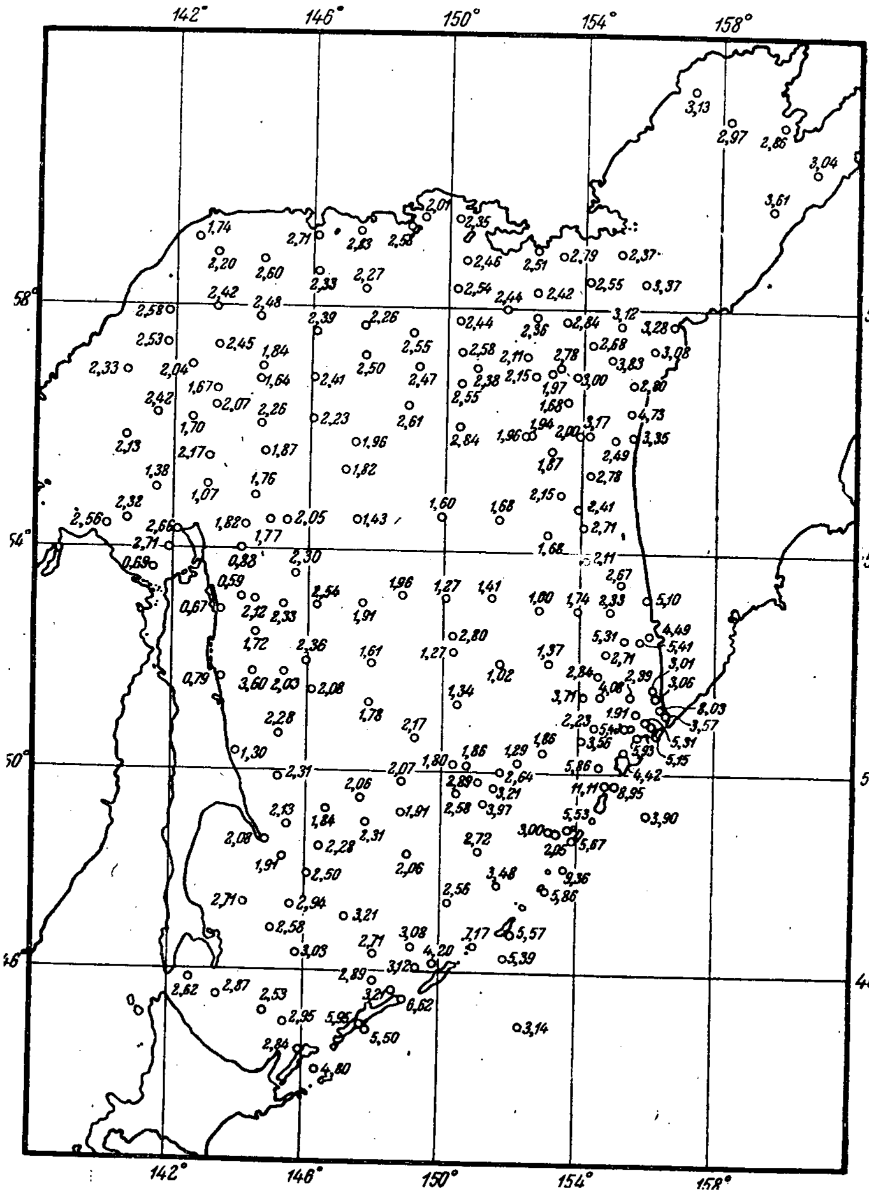


Рис. 1. Содержание железа в процентах в осадках Охотского моря по отдельным станциям

Продукты извержении вулканов Курильских островов представлены главным образом обломочным материалом, что характерно для районов современной вулканической деятельности вообще [11]. По составу этот материал в подавляющем большинстве случаев отвечает андезитам и базальтам; следовательно, видное место в нем принадлежит тем же магнетиту и пироксенам. Например, пепел вулкана Креницына (о. Оне-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

котан), собранный на палубе корабля, находившегося в море в 5 милях южнее мыса Креницына, содержал около 1,5% магнетита и 5% пироксенов. По минералогическому составу он был идентичен пироксеновому андезиту с содержанием $SiO_2 = 61,54\%$.

Как продукты дезинтеграции горных пород, так и пирокластический материал действующих вулканов Курильских островов обогащены железосодержащими минералами. Это же характерно для аллювия рек и пляжей песков Курильского района. Так, в песке, взятом на пойме реки одного из крупных островов, оказалось 8,5% магнетита и 15% пироксенов. Пляжевые пески Курильских островов в большинстве случаев являются магнетитово-пироксеновыми концентратами с максимальным содержанием до 20% магнетита и 64% пироксенов. На одном из островов на пляже был обнаружен пироксеновый концентрат, состоявший из авгита и гиперстена, с незначительной примесью магнетита и обломков пород. В пробах песков, взятых на островных отмелях, было установлено содержание до 10% магнетита и 7% пироксенов.

Широкое развитие андезитов и базальтов характерно также и для питающих провинций Камчатки, что объединяет их с питающими провинциями Курильских островов. Согласно данным А. Н. Заварицкого [11] и В. И. Влодавца [8], среди потухших вулканов Камчатки около 60% характеризуются андезитовыми, 30% базальтовыми, 4% андезито-базальтовыми и 6% риолитовыми и дацитовыми лавами. Действующие вулканы извергают авгитовые и гиперстеновые андезиты, андезито-базальты и базальты; только Карымский вулкан дает преимущественно дацитовую лаву. Основными компонентами пеплов наиболее активного из современных вулканов Камчатки — Ключевской сопки — являются вулканические стекла (черные, зеленые, бурые), плагиоклазы (лабрадор, битовнит), авгит, магнетит, гиперстен и оливин [6, 7, 10, 18, 31].

Обломочный материал, покрывающий поверхность суши и поступающий в море с побережий Камчатки в виде продуктов разрушения горных пород и пирокластического материала, характеризуется, подобно обломочному материалу курильских питающих провинций, высоким содержанием железосодержащих минералов. Ю. В. Ливеровским [17] в составе скелетной части верхних горизонтов почв в долине р. Камчатки было обнаружено в тяжелой подфракции 19—59% рудных минералов, 39,5—78% пироксенов и 1,5—14% роговой обманки. В образцах песков, собранных на пойме и I надпойменной террасе нижней части реки у пос. Озерного, нами установлено наличие в тяжелой подфракции 26—65% магнетита и 13—37% пироксенов. В одной из проб песка, взятой у берегов южной Камчатки, оказалось 9% магнетита и 8% пироксенов.

Как видно на рис. 2, концентрации железа в осадках Курильского района более высокие, а в осадках Камчатского района несколько снижаются. Это связано с особенностями распределения железосодержащих минералов, к которым в первую очередь относятся магнетит, пироксены и некоторые обломки пород.

Если Курильские острова характеризуются почти сплошным развитием изверженных пород и их туфов, то на Камчатке можно наблюдать обширные площади, сложенные осадочными и метаморфическими породами [9, 30 и др.]. Продукты разрушения последних оказывают местами заметное влияние на состав обломочного материала, снижая концентрации железосодержащих минералов. Кроме того, Курильские острова малы по площади и поэтому пирокластический материал, поступающий из вулканов в море, мало меняет минералогический состав в результате дифференциации. На Камчатке же некоторые действующие

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

вулканы находятся на расстояниях до 400 км от береговой линии. Поскольку содержание тяжелой подфракции в пеплах довольно быстро уменьшается с удалением от очагов извержения [18], пирокластический материал камчатских вулканов выпадает из воздуха в море в значи-

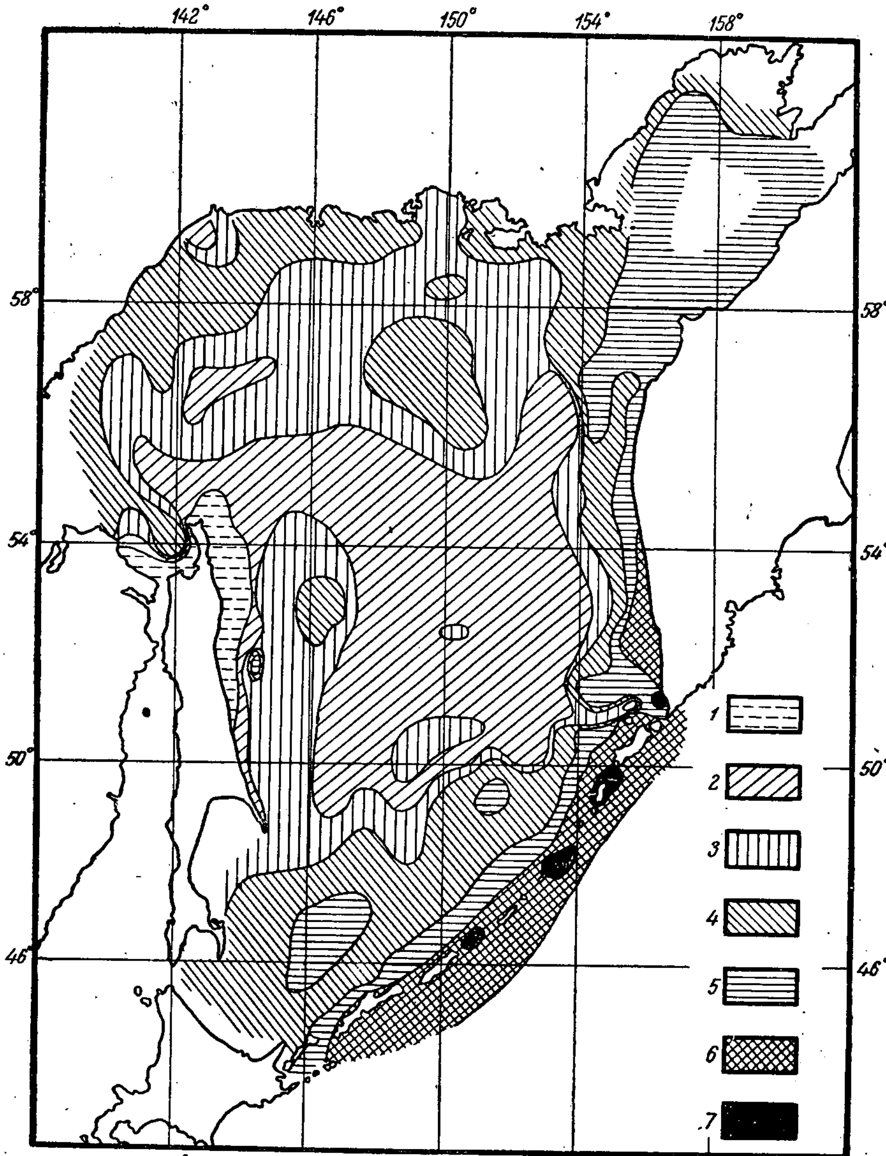


Рис. 2. Распределение железа в осадках Охотского моря (в процентах): *1* — менее 1; *2* — 1 — 2; *3* — 2 — 2, 5; *4* — 2,5 — 3; *5* — 3 —5; *6* — 5 — 7; *7* — более 7%

тельной степени обедненным железосодержащими минералами. Наконец, Курильский район характеризуется наличием сильных приливо-отливных течений, и поэтому подвижность придонных вод здесь значительно выше, чем в Камчатском районе. Соответственно этому в Курильском районе более ярко выражен процесс естественного шли-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

хования, ведущий к повышению концентрации железосодержащих минералов в осадках.

Рассмотрим теперь, каково распределение железа в осадках других прибрежных районов Охотского моря. В осадках прибрежных районов от п-ова Тайгонос до Сахалинского залива концентрации железа по сравнению с Курило-Камчатским районом заметно снижаются. Так, железа в песках здесь в среднем содержится около 2,5%, в алевритовых илах 2,5—3%. Снижение содержания железа в осадках связано прежде всего с изменением характера поступающего с побережий в море обломочного материала. Для питающих провинций части побережья Охотского моря от п-ова Тайгонос до Сахалинского залива [3, 4, 5, 13, 14, 15, 16] характерно широкое развитие пород меловой вулканогенной толщи (порфириты и их туфы, фельзиты, липариты, андезиты и базальты) и меловых кислых интрузий (биотитово-роговообманковые гранодиориты и граниты). Только на шантарском побережье наблюдается распространение сланцев, алевролитов и песчаников триаса и юры, а на побережье Сахалинского залива и Амурского лимана до г. Николаевска — кайнозойских эффузивов (оливиновые базальты, андезиты и липариты). Пространства, сложенные этими эффузивами, относительно невелики и поэтому характер поступающего с побережья в осадки обломочного материала определяется главным образом распространением в питающих провинциях вулканогенной толщи и меловых интрузий. Вследствие этого в тяжелых подфракциях осадков прибрежных районов от п-ова Тайгонос до Сахалинского залива ведущее место принадлежит, помимо обломков пород, роговым обманкам и эпидоту, а магнетит и пироксены присутствуют лишь в небольших количествах. Содержание тяжелой подфракции в осадках здесь гораздо ниже (до 15—20%), чем в Курило-Камчатском районе (до 80—90%).

Еще более низкое содержание железа наблюдается в песках (0,59—2%) и алевритовых илах (2—2,5%) прибрежных районов Сахалина. Здесь железо связано главным образом с обыкновенными роговыми обманками и эпидотом, которыми изобилуют тяжелые подфракции третичных песчано-глинистых отложений Сахалина [19, 23]. Продукты разрушения третичных толщ играют основную роль в сложении осадков присахалинского района, но содержание тяжелой подфракции в этих осадках также невелико (5—10%), как и в осадках прибрежных районов от п-ова Тайгонос до Сахалинского залива [21, 22].

Обращает на себя внимание то обстоятельство, что в прибрежных районах от п-ова Тайгонос до Сахалинского залива и Сахалина содержание железа в алевритовых илах выше, чем в песках. Это, по-видимому, можно связывать с распределением железосодержащих минералов по фракциям. Установлено, что такие минералы из осадков Охотского моря, как магнетит, роговые обманки и эпидот более всего тяготеют к алевритовым фракциям [22]. В районах, где главным железосодержащими минералами являются роговые обманки и эпидот, это должно вызывать некоторое обогащение железом алевритовых осадков. Как уже упоминалось, в породах Камчатки и Курильских островов главными железосодержащими минералами являются магнетит и пироксены. Пироксены по своим исходным размерам соответствуют более всего песчаным фракциям. Магнетит, при формировании осадков в условиях подвижной водной среды, в силу своего большого удельного веса накапливается в песках, особенно в мелких. Крупноалевритовая фракция из таких песков часто более чем на 50% слагается магнетитом. Вследствие этого в алевритовых илах мы встречаем больше, чем в песках плагиоклазов и вулканических стекол, но меньше пироксенов и магне-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

тита. Очевидно, этим объясняется довольно резкое снижение содержания железа при переходе от песков к алевритовым илам в Курило-Камчатском районе.

Изложенные данные показывают, что распределение железа в песчаных и алевритовых осадках прибрежных районов Охотского моря тесно связано с распределением железосодержащих минералов, поступающих с обломочным материалом с побережий. Несколько иначе обстоит дело в открытых частях моря — в области распространения тонких глинисто-диатомовых и диатомовых илов. В песчано-алевритовых фракциях этих осадков преобладают обломки пород, легкие вулканические стекла и плагиоклазы [22]. Железосодержащих минералов здесь чрезвычайно мало. Основная масса железа в тонких осадках находится в виде окислов и сернистых соединений (гидротроилит, марказит). С повышенными концентрациями железа в осадках открытого моря мы встречаемся в южной глубоководной котловине и в котловине Дерюгина, где глинисто-диатомовые илы имеют с поверхности бурый окисленный слой. Этот слой обладает почти одинаковой мощностью как в той, так и в другой котловинах, что говорит о сходстве окислительно-восстановительных условий. Однако содержание железа в осадках южной глубоководной котловины равно 2,5—5%, тогда как в осадках котловины Дерюгина 2—3%. Несомненно, что южная котловина Охотского моря находится под сильным влиянием береговых питающих провинций и действующих вулканов Курильских островов. В эту же котловину выносятся течениями и воздушными потоками наиболее тонкие фракции продуктов дезинтеграции горных пород и пирокластического материала, образующие алевритовую и в какой-то мере пелитовую части глубоководных осадков.

Установлено, что магнетит и пироксен играют заметную роль в тяжелой подфракции тонкозернистой части вулканического пепла. При анализе пепла вулкана Креницына обнаружилось, что при переходе от крупноалевритовой к мелкоалевритовой фракции содержание тяжелой подфракции уменьшилось почти в 11 раз (с 10,72 до 0,98%), но в тяжелой подфракции мелкого алеврита имелось 23,5 магнетита и 18% пироксенов. Эти же минералы, правда в меньших количествах, наблюдались и во фракции менее 0,01 мм. Кроме выноса тонкого обломочного материала, некоторую роль в обогащении осадков южной глубоководной котловины Охотского моря, по-видимому, играют минеральные источники с сильно железистыми водами, которые на Курильских островах встречаются довольно часто. Таким образом, в осадках южной котловины больше железа вообще и больше его поступает, по-видимому, в верхние слои осадка в процессе диагенетического перераспределения [25, 26, 27, 28].

В осадках обширного пространства центральной части Охотского моря, включающей котловину Тинро, содержание железа равно всего лишь 1—2%. Следует отметить, что условия осадкообразования во впадине Тинро несколько отличаются от таковых во впадине Дерюгина и южной глубоководной впадине. Окислительный потенциал в верхнем слое осадков в котловине Тинро низок, поэтому здесь не наблюдается обогащения их гидроокислами железа, но довольно резко выражен процесс образования сульфидов железа. Котловина Тинро является одним из редких участков в Охотском море, где в поверхностном слое осадков отмечается сравнительно большое количество марказита в крупноалевритовой фракции. В центральной части Охотского моря также не наблюдается обогащения поверхностного слоя осадков гидроокислами железа в процессе его диагенетического перераспределения. На пони-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

жении концентрации железа в котловине Тинро и центральной части Охотского моря сказывается также разбавляющее действие аутигенного (аморфного) кремнезема, содержание которого в осадках этих мест равно 30—56% [1].

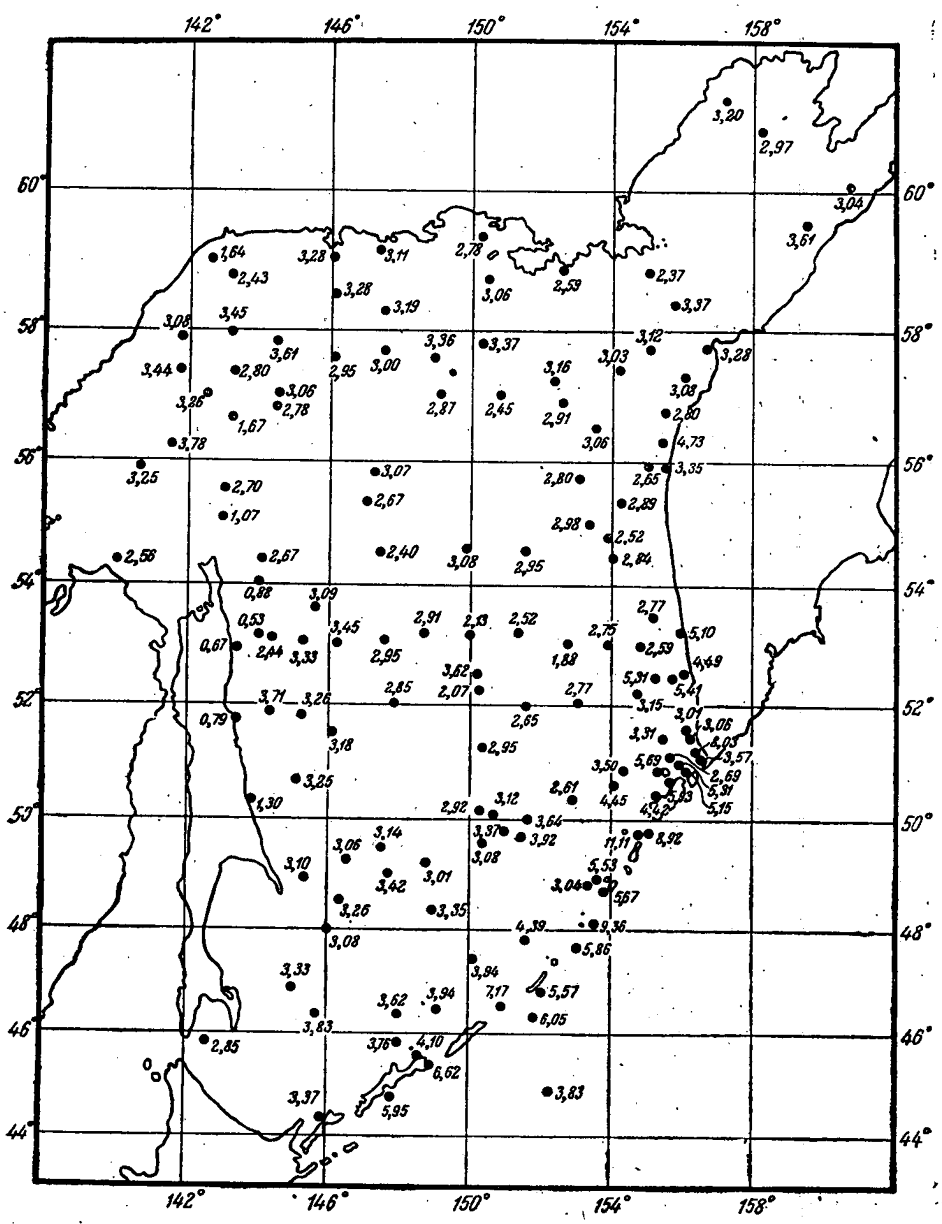


Рис. 3. Содержание железа в процентах в расчете на материал без $CaCO_3$ и аморфного SiO_2 по отдельным станциям

Описанный характер распределения железа в поверхностном слое осадков Охотского моря хорошо иллюстрируется как рис. 2, так и рис. 3, 4, где распределение железа показано на основе расчета без карбоната кальция и аморфного кремнезема.

Интересно вкратце коснуться вопроса распределения железа по

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

вертикали. В подтверждение сделанному Н. М. Страховым выводу о диагенетическом перераспределении железа в тонких осадках, материалы, полученные нами при исследовании осадков открытой части

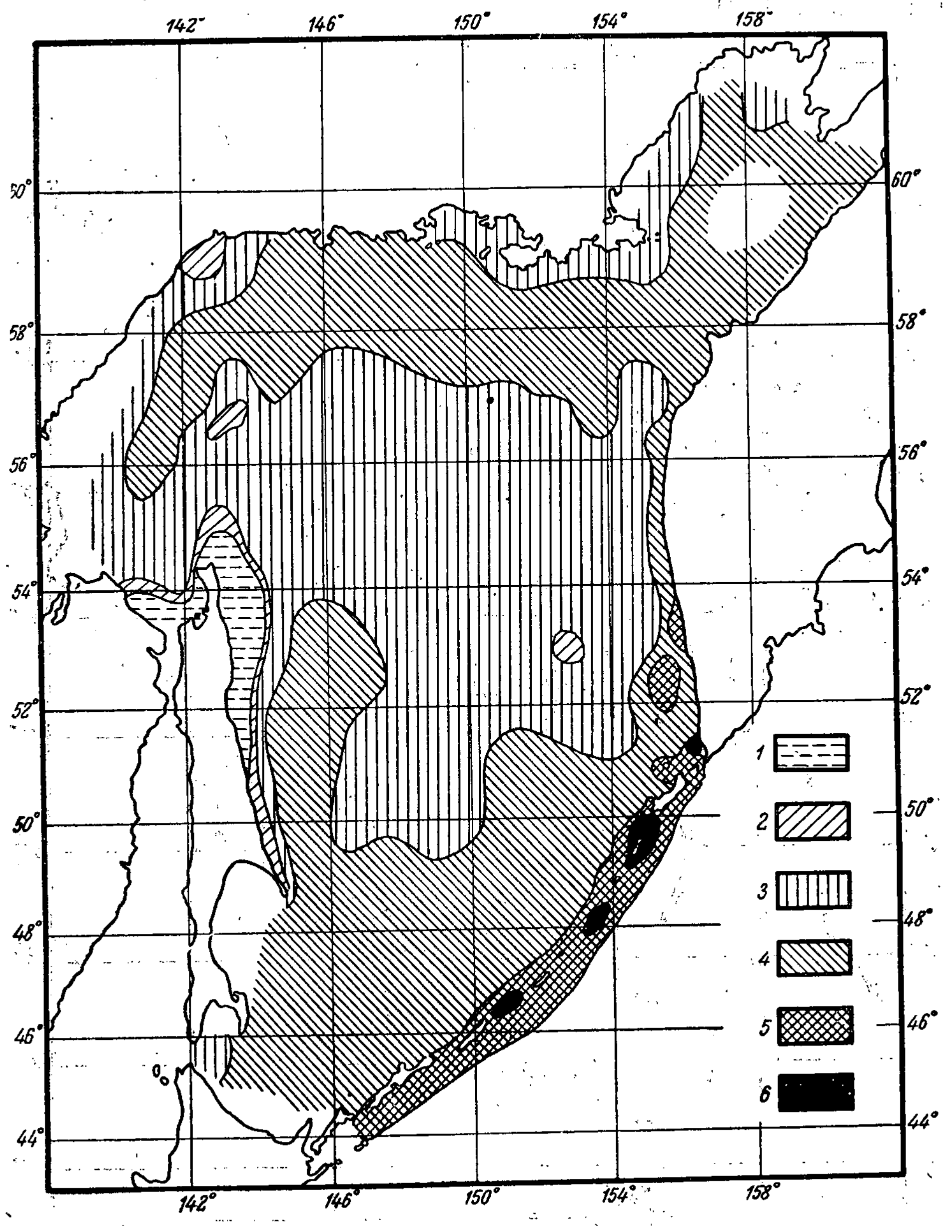


Рис. 4. Распределение железа в осадках Охотского моря в расчете на материал без $CaCO_2$ и аморфного SiO_2 (в процентах):
1 — менее 1; *2* — 1 — 2; *3* — 2 — 3; *4* — 3 — 5; *5* — 5 — 7; *6* — более 7%

Охотского моря, показывают повышенные концентрации двухвалентного железа по мере углубления в толщу осадка (таблица).

Достоин внимания следующий интересный факт. В глинисто-диатомовых илах с высоким содержанием аморфного кремнезема, в восстановительной зоне, расположенной непосредственно под зоной окисле-

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Таблица

Повышение с глубиной количества двухвалентного железа

Котловина Дерюгина			Южная глубоководная впадина		
горизонт, см	характер пробы	содержание Fe^{II}, %	горизонт, см	характер пробы	содержание Fe^{II}, %
0—10	Ил глинисто-диатомовый коричневый	0,01	0—15	Ил глинисто-диатомовый коричневый	0,02
25—30	Ил глинистый серый с зеленоватым оттенком . .	3,20	16—18	Ил глинисто-диатомовый, зеленовато-серый . . .	4,45
67—71	Ил глинистый серый с голубоватым оттенком . .	4,18	20—22	Ил глинисто-диатомовый зеленовато-серый . . .	2,30

ния, количество двухвалентного железа оказывается в ряде случаев больше, чем в нижележащих слоях. Поскольку железо в ионной форме здесь находиться не может, так как это противоречило бы законам диффузии, можно предположить, что оно частично реагирует с аморфным кремнеземом с образованием силикатов.

Подводя итоги изложенному выше, можно заключить, что основная масса железа поступает в осадки Охотского моря с обломочным материалом, представленным, с одной стороны, продуктами дезинтеграции горных пород суши, а с другой — продуктами современной вулканической деятельности. Больше всего железа, связанного с обломочным материалом, поступает со стороны Курильских островов и Камчатки, располагающихся в пределах андезитовой зоны, и меньше — со стороны северного и северо-западного побережий, являющихся областью преимущественного развития меловой вулканогенной толщи и меловых кислых интрузий. Совершенно незначительно поступание железа с обломочным материалом Сахалина, в составе которого главными компонентами являются плагиоклазы, кварц и калиевые полевые шпаты. В обломочном материале Курильских островов и Камчатки железо связано главным образом с магнетитом и пироксенами. Основная масса магнетита приурочена к крупноалевритовой и мелкопесчаной фракциям, а пироксенов — к песчаным фракциям. С северного побережья железо поступает, по-видимому, в виде составной части обломков пород, обильных как в алевритовых, так и в песчаных фракциях.

Концентрации главных железосодержащих минералов в поступающем в осадки обломочном материале и распределение этих минералов по гранулометрическому спектру определяют характер распределения железа в донных отложениях Охотского моря. Наиболее высокие кларковые содержания железа приурочены к песчано-алевритовым осадкам Курило-Камчатской зоны, а затем к песчано-алевритовым осадкам северной прибрежной зоны. Осадки центральной части моря значительно обеднены железом. Это отличает Охотское море от других морей [29 и др.], в которых кларковые содержания железа возрастают обратно пропорционально среднему диаметру частиц осадков. Поэтому Охотское море, с точки зрения распределения железа в его донных отложениях, можно рассматривать в качестве особого типа морского бассейна — бассейна с максимальными кларковыми концентрациями железа в прибрежной зоне. В этом бассейне питание осадков железом

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7

осуществляется главным образом за счет крупных фракций обломочного материала, поступающего из обогащенных железосодержащими минералами питающих провинций, на территории которых преобладает физическое выветривание горных пород.

ЛИТЕРАТУРА

1. Безруков П. Л. Донные осадки Курило-Камчатской впадины. Тр. Ин-та океанологии АН СССР, т. 12, 1955.

2. Безруков П. Л. и Удинцев Г. Б. Новые данные о геологическом строении дальневосточных морей. ДАН, т. 91, № 2, 1953.

3. Богданович К. И. Очерк деятельности Охотско-Камчатской экспедиции 1895—1898 гг. Изв. Рус. геогр. о-ва, вып. 6, 1899.

4. Богданович К. И. Предварительный отчет о поисковых и разведочных на золото работах, произведенных Охотско-Камчатской экспедицией на северо-западном берегу Охотского моря. Горн. журнал, т. 3, № 7—8, 1899.

5. Богданович К. И. Западное побережье Охотского моря от Николаевска до Охотска. Сб. памяти И. В. Мушкетова, 1905.

6. Влодавец В. И. Восхождение на Ключевской вулкан. Бюл. вулканол. станции на Камчатке, № 1, 1937.

7. Влодавец В. И. Ключевской вулкан. Землеведение, нов. сер., т. XLI, 1940.

8. Влодавец В. И. Вулканы Советского Союза. Географиздат, 1949.

9. Дьяков Б. Ф. Геологические исследования на западном берегу Камчатки. Тр. Нефт. геол.-разв. ин-та, сер. А, вып. 88, 1935.

10. Заварицкий А. Н. Северная группа вулканов Камчатки. Изв. АН СССР, сер. камчатская, вып. 1, 1935.

11. Заварицкий А. Н. О вулканах Камчатки. Камчатск. сборник, 1, 1940.

12. Заварицкий А. Н. Вулканическая зона Курильских островов. Вестн. АН СССР, № 1, 1946.

13. Казанский П. А. Предварительный отчет о геологических исследованиях вдоль северного побережья Охотского моря в 1912 г. Изв. Геол. ком., т. XXXII, № 7, 1913.

14. Казанский П. А. Краткий отчет о работах 1917 г. Изв. Геол. ком., т. XXXVII, № 1, 1918.

15. Криштофович А. Н. Геологический обзор стран Дальнего Востока, 1932.

16. Кропоткин П. Н. и Шаталов Е. Т. Очерки геологии северо-востока СССР. Материалы по изучению Охотско-Колымского края, сер. 1, вып. 3, 1836.

17. Ливеровский Ю. Почвы Камчатки. Камчатск. сборник, 1, 1940.

18. Набоко С. И. Продукты извержения Ключевского вулкана в 1937—1938 гг. Тр. лабор. вулканологии и Камчатск. вулканол. станции, вып. 4, 1947.

19. Немова Э. Н. Минералогический состав третичных осадков правобережья р. Ыркры. Тр. Нефт. геол.-разв. ин-та, сер. А, вып. 45, 1934.

20. Остроумов Э. А. Железо в донных отложениях Охотского моря, ДАН, т. 102, № 1, 1955.

21. Петелин В. П. Минералогическое районирование Охотского моря. Тр. Ин-та океанологии АН СССР, т. 13, 1955.

22. Петелин В. П. Минералогия песчано-алевритовых фракций осадков Охотского моря. Тр. Ин-та океанологии АН СССР, т. 22, 1957.

23. Смехов Е. М. Геологическое строение Сахалина. Изв. АН СССР, сер. геол., № 1, 1947.

24. Соловьев А. И. Курильские острова. Изд: Главсевморпути, 1947.

25. Страхов Н. М. К познанию закономерностей и механизма морской седиментации. I. Черное море. Изв. АН СССР, сер. геол., № 2, 1947.

26. Страхов Н. М. Распределение железа в осадках озерных и морских водоемов и факторы, его контролирующие. Изв. АН СССР, сер. геол., № 4, 1948.

27. Страхов Н. М. К вопросу об общей теории осадочного процесса. Изв. АН СССР, сер. геол., № 4, 1950.

28. Страхов Н. М. Диагенез осадков и его значение для осадочного рудообразования. Изв. АН СССР, сер. геол., № 5, 1953.

29. Страхов Н. М., Бродская Н. Г., Князева Л. М., Разживина А. Н., Ратеев М. А., Сапожников Д. Г., Шишова Е. С. Образование осадков в современных водоемах. Изд-во АН СССР, 1954.

30. Щербаков А. В. Геологическое строение п-ва Камчатка по работам экспедиции Академии наук СССР. Междунар. геол. конгр., тр. XVII сес., т. 2, 1937.

31. Bogdanowitsch A. K. Geologische Skizze von Kamtschatka, Dr. A. Petermanns Geogr. Mitteil., Jahrg. 1904, H. III, Gotha Justus Perthes, 1904.

Approved For Release 2009/07/31 : CIA-RDP80T00246A007500290001-7